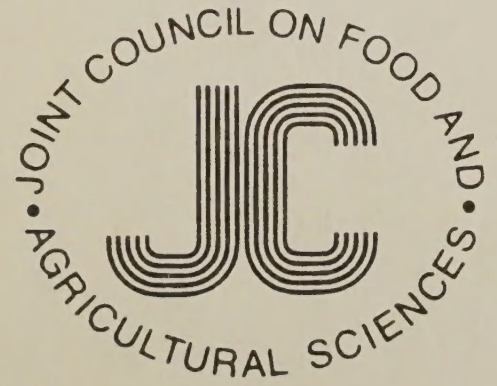
Areas of Emphasis in the Food and Agricultural Sciences for the Early 1980's



Joint Council
on Food and
Agricultural Sciences

March, 1980

AREAS OF EMPHASIS IN THE FOOD AND AGRICULTURAL SCIENCES FOR THE EARLY 1980's

A Report of the Joint Council
on Food and Agricultural Sciences

March 1980

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Table of Contents

SUMMARY

The Joint Council has developed projections of areas for increased emphasis in the food and agricultural sciences for the early 1980's. These projections are intended to serve as a general guide and planning aid as well as a response to the Congressional mandate under Title XIV of the 1977 Food and Agriculture Act (PL 95-113). The general focus of these projections is on issues and concerns judged to be important to the food and agricultural sciences in the next 5 years. While the projections are based on many recent analyses and studies, this report is not intended merely as a summarizing document. Rather, it is meant to provide a synthesis of available information relating to the setting and issues now facing the food and agricultural sciences and/or likely to become critical in the next 5 years.

The economic setting in which the food and agriculture system finds itself is described as one of continuing inflation, rising unemployment, and a slowing of economic growth worldwide. The per capita world food supply has increased slightly, chiefly in the developed countries. However, continued population growth, along with the need for improved diets for much of the world, will place added strain on food production capacity.

The broad issues and needs facing the U.S. food and agricultural sciences are described as:

- Increasing output and efficiency in agricultural and forestry production, with special concern for the plateauing of crop yields and projected declines in rates of agricultural productivity growth and in wood supplies

- Developing alternative energy sources and conservation practices

- Protecting the natural resource base and environmental quality in the face of increased demands for food, fiber, and wood production

- Improving technical and economic efficiency in our marketing system

- Increasing the value and efficient utilization of human resources for agriculture, forestry, and rural America generally

- Improving consumer products and our standards of living. This includes the safety, quality, and composition of food; human nutrient requirements and food consumption patterns; and the need to expand homemaking capabilities and improve family living conditions

- Promoting equal employment and education opportunities in the food and agricultural sciences

- Contributing more effectively to international cooperation and agricultural development
- Improving industry-university-Federal cooperation, coordination and communication.

These issues and concerns provide the framework for a listing of areas of emphasis for increased resource commitments in the next 5 years. These are listed under headings of: Productivity and Crop Yield Levels, Energy, Basic Research, Water Resources, Conservation of Natural Resources, Weather and Crop Yield Forecasting, Integrated Pest Management, Forestry Production and Management, Rangeland Improvement, Improving Crop and Animal Productivity and Protection, Marketing and Cost Reduction, Post-harvest Processing-Handling-Storage-Distribution, Improving Socioeconomic Aspects of Rural Living, Improving Human Nutrition, Food and Consumer Concerns, Training and Manpower Needs, International Cooperation, and Technology Assessment.

No priorities or ratings are attached to these; all are important for future consideration in our very complex food and agricultural system. All are considered to have research, extension, and higher education components but in varying degrees.

The importance of maintaining a strong, continuing base of ongoing programs is emphasized and is especially significant in the light of recent studies indicating the very high rates of return to investments in agricultural and forestry research and education.

INTRODUCTION

The primary purpose of this report is to summarize the major issues and problems toward which the Food and Agricultural Sciences can be expected to make positive contributions over the next 5 years. The report is not intended as a 5-year plan of work for each of the components of the publicly funded food and agricultural science system. Rather, it is meant to convey a sense of direction and to identify broad areas for increasing emphasis for the system as a whole as it looks toward the future.

The process of change and innovation which has created present-day U.S. agriculture has been heavily dependent on science and education. By helping to expand the effective capacity of both the human and natural resource base of this country, science and education have contributed to a level of national agricultural abundance unequaled in the history of humankind.

A system of publicly funded research, extension, and higher education in the food and agricultural sciences has been a prominent contributor to this process. The roots of this system extend into the fundamental physical, biological, and social sciences. Its branches interface directly with the people of rural America; with the owners and users of natural resources; with producers, marketers, and consumers of food, natural fibers, and wood products; and with other units of government which perform service or regulatory functions having to do with food, agriculture, or natural resources. The system generally provides input to and complements the wide array of research, product development, and information disseminating activities carried out by the private sector.

The past accomplishments of the system have been widely observed and commended. The value of significant developments as well as overall rates of return on investment for major components of the system have been measured in a number of different contexts over different time periods. The nearly universal conclusion of these analyses is that the public has reaped benefits and realized rates of return from expenditures within this system far in excess of returns normally expected from prudent investments in the private sector. Consequently, no attempt is made in this report to further document past accomplishments, nor to evaluate the system's performance. Rather, the focus of this report is toward the future. Despite the rapid technological and economic advances achieved to date, complex problems remain. Failure to address many of these problems at some level in our society could have catastrophic consequences. Further, as the evidence of recent history suggests, hidden within today's problems well may lie the opportunities for continued progress in the years ahead.

This report draws freely on various documents and publications prepared within the system or by its major user or clientele groups. It also draws on appraisals, studies, and projections related to agricultural

science and education made by others. In this respect, the report represents an overview of the various planning and projecting activities employed within this decentralized, pluralistic system.

In the sections which follow, an attempt first is made to preview some of the expected economic forces, both domestic and worldwide, which are largely external to U.S. agriculture but which will bear importantly on its future development. Next is a summary of the major issues and needs to be addressed by the food and agricultural sciences in the years ahead. The report concludes by proposing broad areas for increasing program emphasis for research, extension, and higher education over the upcoming 5-year period.

EXTERNAL FORCES LIKELY TO IMPACT U.S. AGRICULTURE

Interrelationships among the basic industries of agriculture and forestry and the other sectors of the domestic economy are numerous and complex. Events of the past decade also demonstrate the degree to which U.S. producers and consumers of agricultural and forest products are affected by changing world supply and demand conditions.

Following this same theme but cast in a slightly different framework, the chances are greater than they ever have been that developments in the nonagricultural sectors of our economy or in the international arena will affect U.S. producers and consumers of agricultural and forest products. Consequently, before turning to specific program needs or recommendations for the food and agricultural sciences we should look, as best we can, into the future for these "external" conditions.

The U.S. Economy

Continued inflation, higher unemployment, and slower economic growth are the central themes of most economic forecasts for the U.S. economy in the early 1980's.

Inflation has been termed the number one economic problem facing the nation. As measured by the Consumer Price Index, inflation averaged 11 percent for 1979 relative to a year earlier. Although the rate may decline somewhat by late 1980, it will remain high by historical standards. An average rate of between 8 and 10 percent for the first 3 years of the 1980's is likely without additional incentives to improve productivity, conserve energy, and stimulate savings.1/

Real economic growth--the change in gross national product after adjusting for inflation--averaged about 5 percent per year during the 1975-78 period following the 1974 recession. Most economists agree that another recession is either now in progress or on the way although its likely severity and duration are subject to debate. In any case, real growth in 1980 is expected to be very low or nonexistent with a slowly rising trend beginning in 1981 and 1982. Total employment and consumer demand likely will grow relatively slowly during the next year or two with the pace quickening as the eventual recovery gains momentum.

High and rising prices for petroleum products and other forms of energy are widely viewed as a major contributor to this country's current economic problems. Consequently, pressures will continue to mount to find

1/ Food and Agriculture: Policy Issues for the 1980's, Presentation by Howard Hjort, (Director of Economics, Policy Analysis, and Budget, USDA) at the 1980 Agricultural Outlook Conference, Washington, D.C., November 6, 1979.

ways to conserve energy, to find alternative energy sources, and to increase output from known domestic sources. Despite these efforts, we will continue to need a large volume of imported oil. With further price increases for crude oil in store, import costs will continue to rise and work in the direction of continued deficits in our foreign trade account.

World Economic Conditions

Economic growth rates are expected to remain low by historical standards for the next 2 to 3 years throughout much of the world. Rising energy prices and inflation will be adversely affecting most of the industrialized world in much the same way as in the United States. By the same token, real growth rates may begin to rise as means are developed to circumvent energy shortages and other bottlenecks.

World financial markets and currency exchange rates will remain volatile. Supply and demand fluctuations inherent to the major commodities traded in world markets as well as the fiscal and monetary policies carried out by various governments will contribute to these unsettled conditions. As long as crude oil is in short supply relative to demand, the tendency will persist for world financial reserves to shift toward major oil exporting countries. This, in turn, will result in continued pressure on oil importing countries to devaluate currencies or find other means of increasing exports or acquiring foreign exchange credits. For the United States, high levels of food and other agricultural exports will be required to soften the impact of rising world oil prices. Developing countries which must import both oil and food will be especially hard-hit in the absence of additional aid from the developed world or from oil exporting nations.

World Agriculture

Total world agricultural output has been increasing at an average annual rate of about 2 1/2 percent for the past two decades. With world population increasing roughly 2 percent per year, a net improvement in the per capita food supply is implied. However, much of this increased per capita production has occurred in the developed countries where population growth has been relatively slow and diets have been shifting to more meat and animal products. Although per capita food production in the developing countries has increased slightly during this period, the group of "most severely affected" (MSA) countries has experienced a slightly declining rate of change in food production over most of the past decade.2/

2/ The State of Food and Agriculture 1979, The Director-General's report to the Twentieth Session of the Conference of the Food and Agriculture Organization of the United Nations, August 1979.

World agricultural production was up almost 3 percent in 1978 reflecting particularly large grain harvests. After 4 consecutive years of stock accumulation, world stocks of cereal grains at the close of the 1978/79 marketing year were at record levels representing the equivalent of about 16 percent of annual usage. However, preliminary indications for 1979/80 suggest a substantially smaller world grain crop and a significant drawdown in stocks by the end of the marketing year. Thus, the cushion against adverse weather and smaller crops in future years again will be reduced.

World population growth may be slightly lower in the early 1980's than it was during the late 1970's. However, rates will continue much above the world average through much of Africa, the Middle East, and most of Middle and South America. Further, while the long term growth rate in the world population may be slowly subsiding, the absolute number of people inhabiting this planet will continue to grow for many years to come. Barring presently unforeseen developments, world agriculture will need to produce at nearly full capacity to keep pace with population growth during the decade of the 1980's. A significant improvement in the diets of a large share of the world population would put even more strain on productive capacity.

ISSUES AND NEEDS TO BE ADDRESSED BY THE FOOD AND AGRICULTURAL SCIENCES

In this section, attention is focused more specifically on the major issues or needs facing the food and agricultural sciences. Many of the issues which will demand response in the future have been addressed by science and education programs in one form or another for many years. Other issues or aspects of continuing issues are the product of current or anticipated future events.

In listing and describing the issue areas, no attempt is made to assess their relative importance or to assign numerical priorities. Rather, they are put forth as areas of concern which are expected to exist simultaneously in the years ahead. For the most part, the question for the food and agricultural science system is not which of the areas to address but how to allocate resources in order to address the entire set most effectively. Thus, the intent of the following listing is to set forth the issues to indicate the broad scope of responsibilities to be shared among the various components of the food and agricultural science system.

Increasing Output and Efficiency in Agricultural and Forest Production

Considerable concern is currently being expressed about apparent declines in rates of productivity increase in both the industrial and agricultural sectors. Although there is lack of consensus about the cause and the extent of the alleged "leveling off"--especially in agriculture--there is a general consensus of concern about declining rates of increase of crop yields in the U.S. Insufficient data are available for specific conclusions to be drawn, and this paucity permits varying interpretations and assertions. A recent study concluded that the annual rate of productivity growth in agriculture has been approximately 1.5 percent per year for the past 50 years, but that it took an alarming drop in the 1960's. Although productivity growth has recovered in recent years, this study concluded that it may drop to 1.1 percent or lower in the long term in the absence of any major technological breakthroughs and without significant increases in investments in agricultural research and education.3/

These concerns about insufficient productivity growth are coupled with current and continuing uncertainties as to commodity price levels, costs of production, availability of energy supplies, impact of environmental regulations, and climatic changes.

3/ Prospects for Productivity Growth in U.S. Agriculture, by Yao Chi Lu, Phillip Cline, and Leroy Quance, Agricultural Economic Report No. 435, ESCS, USDA, Washington, D.C., September 1979.

The U.S. will continue to need greater output of food, fiber, and wood products in the future to meet increasing domestic demands and to provide larger quantities for export. At the same time, the resources used in producing these products will be needed increasingly for other purposes.

World needs for greater output will be even more critical in light of continued world population growth, the large masses of people with substandard diets or living conditions, and future demand expansion resulting from economic development. In addition to humanitarian concerns, the U.S. will continue to have an important stake in assisting countries in their need to increase output in the interest of promoting world peace and developing future trading partners.

Along with needs for increased total production is the need to reduce wide variations in output. The vulnerability of agricultural production to the vagaries of weather or other disruptive influences has been demonstrated over and over through the course of history. The effects of these disruptions are most harshly expressed when conditions are so widespread as to result in starvation and deprivation for large numbers of people. Less severe in terms of human suffering but increasingly intolerable, nevertheless, are the economic shock waves which are transmitted through interdependent industrialized economies when supplies of basic commodities and raw materials are even temporarily disrupted.

Overlapping the needs for more output and less supply variability is the need for improved production efficiency. This works first in the direction of increasing net returns to producers and subsequently to the benefit of consumers by helping to hold down the rate of inflation. It can also have the effect of making U.S. commodities more competitive in world markets.

While contributing to the general need to reduce inflation, improved efficiency will also be needed to address more specific concerns. For example, more efficient use of the natural resources commonly used in the production of food, fiber, and wood products will be needed to compensate for the loss of these resources to other uses. More efficient use of nonrenewable resources, such as fossil fuels, in the production of agricultural commodities will be needed as part of the national effort to conserve supplies. More efficient or constrained use of chemicals may also be necessary in order to limit unnecessary exposure of people, animals, or the environment to substances which either have been or might sometime be shown to be harmful. Even the efficiency of labor, which has increased so dramatically in the past, stands in need of further improvement in many segments of agricultural and forest production.

Actual or potential conflicts among the individual forms of efficiency are apparent. For example, the need to increase labor efficiency runs counter to the need to conserve energy. Efficiency in the use of natural resources, historically, has been accompanied by increased use of

fertilizer and nonrenewable resources. Consequently, a major need for the future will be to recognize, reduce, and resolve such conflicts.

The U.S. food and agriculture science system has compiled an impressive record in the development of both output-increasing and input-saving technology. Due in part to this past success, the U.S. presently has the capacity to produce normal market needs and at times price-depressing surpluses in the absence of widespread weather problems or similar disruptions. However, events of the past decade suggest that the margin between surplus and scarcity is not wide. Moreover, the time required to develop new technology, the uncertainty of success associated with any particular line of research, and the need to constantly replenish the technological reservoir to combat obsolescence require relatively long-term and continuous commitments.

Developing Alternative Energy Sources and Conservation Practices

Although agriculture is not a major consumer of the Nation's energy supply (about 3 percent for agricultural production and an additional 13 percent for processing and distribution of agricultural products), energy concerns will loom large in the agricultural sector in the next 5 years. Secretary Bergland has proposed a goal of energy self-sufficiency in agriculture by 1990. To reach this goal will require greatly increased energy sources--solar, wind, and biomass--especially in the next 5-year period. Energy conservation for cost reduction also will require major attention. Agriculture will find itself in increasing competition for water in the Western United States due to the increased demand for water by energy facilities--strip mines, oil shale mining and processing. The Nation's crops and forests will receive increased impact regionally from acid rain resulting from increased industrial usage of coal. Also of concern to agriculture is the need to retain sufficient plant residues for maintenance of soil quality and erosion control in the face of potential usage of the residue as an energy source.

Improving and Conserving the Natural Resource Base and the Quality of the Environment

Heightened concerns for natural resources and the environment derive in part from future needs for increased output of food, fiber, and wood products and the need to maintain a productive resource base for future generations. These concerns also reflect the burgeoning demand for the same natural resource base for a wide variety of nonagricultural purposes.

Recreational demands, long an important user of natural resources, continue to increase with more people and more leisure time. Recreational demand may grow even faster in the future if and when the effects of gasoline shortages and the present economic slowdown begin to subside.

Resource competition and environmental disturbances also have existed for many years in the form of land and water usage for industrial or urban development and the use of natural resources for disposal of various forms of industrial wastes or pollutants. These issues will become even more intense in the future as resources become more fully utilized and the level of public awareness continues to increase.

Improving Technical and Economic Efficiency in the Marketing System

U.S. farms and forests basically produce raw materials which undergo a variety of additional processes or transformations before being used by consumers. In recent years, roughly two-thirds of the retail cost of food has been added in the marketing system and the proportion is even higher for most fiber and wood products.

Future needs for improved marketing efficiency encompass several different but related dimensions. Perhaps most apparent is the need for a wide range of input-saving technology, not only to reduce finished product costs and price inflation, but also to reduce demand for scarce inputs such as energy or transportation services. Physical losses of raw materials, marketing inputs, and finished products represent another important aspect of marketing efficiency which needs to be further addressed. Another important dimension has to do with making the most from the raw materials available. As resource constraints become more binding and agricultural commodities become more costly, it will become even more important to develop processes and products for the most complete and effective utilization of commodity supplies.

Both the propriety and the necessity of addressing these technical efficiency issues within the publicly supported science and education system have been challenged at various times. The necessity has been questioned on grounds that marketing firms tend to be large, industrial organizations fully capable of conducting their own research and development programs. Propriety has been questioned on grounds that a relatively small number of marketing firms, compared to the large number of buyers and sellers with whom they deal, might be in a position to capture all of the benefits of improved efficiency in the form of higher profits rather than passing them on or sharing them with producers or the general public.

While these questions provide a valid basis for challenging a particular research or developmental effort, they do not represent a general or universal condition. The total marketing system includes a large number of firms without a significant research and development capability. Further, excess profits have not been widely observed throughout the system, although the competitive performance of particular market segments may be open to debate.

This latter question points up a further dimension of marketing efficiency. As the size of marketing firms continues to increase and their numbers decline, opportunities for monopolistic pricing or other anticompetitive behavior will increase. Thus, there will be a continuing need to assess the economic performance of input and product markets and to provide guidance to various public endeavors to modify market structure or firm behavior.

Developing the Human Resource Base for Agriculture and Rural America

Natural resources, production inputs, and technology take on value as they are used and managed by people to produce goods and services. If the farms and forests, the processing and marketing firms, as well as the various institutions which service or regulate these industries and rural communities, are to meet the expanding needs and challenges of the future, then the skills and capabilities of the people who run them will also need to expand.

This implies a continuing need for vocational and community service activities for rural youth. It implies the need for continued development and improvement of both curricula and course content among higher education programs in the food and agricultural sciences. This need obviously extends through the increasingly costly advanced degree programs where future scientists and educators are developed. Further implied is the need for continuing education of both a general and a technical nature among the adult population of rural areas.

Recent and prospective population growth within much of rural America will present new challenges and opportunities. Regardless of their motives for resettling, these new residents control part of the natural resource base and represent a body of human capital presently or potentially capable of contributing to the economic and social growth of agriculture and rural communities.

Promoting Equal Employment Opportunities

The agricultural science and education community should give increased attention to the significant underrepresentation of blacks and other minorities and of women in agricultural research and education.

Women are still underrepresented, and in some instances relatively underpaid, in the agricultural professional work force, despite the fact that there has been a significant increase in recent years in the number of women receiving baccalaureate and advanced degrees. Increased recruiting and upward mobility efforts appear to be needed.

The number of blacks receiving doctorates in agricultural sciences continues to be exceedingly low. Blacks are decidedly underrepresented in the ranks of agricultural researchers. Additional attention should be given to innovative ways of overcoming the low esteem in which agricultural research and education are held by minorities. Accelerated recruiting efforts (for college enrollment and subsequent employment in agricultural research and education) and stay-in-college incentives also are needed.

Assessing Needs and Alternatives for Rural Economic Growth and Community Development

Increasing demand for natural resources, increasing output of agricultural and forest products, and continuing shifts in regional population patterns suggest that many rural areas will be experiencing more rapid rates of growth in the future than they have in the past. For these areas, the major developmental issues have to do with the provision of institutional and social structures to accomodate growth and resolve potential conflicts among various community interest groups. This implies the need to improve both the conceptual framework and the data base through which these issues can be addressed.

Although the general tendency may be toward more growth, economic and social change seldom occurs smoothly and evenly among regions or among various segments of the population. Consequently, there will be a continuing need to address problems of insufficient growth and the provision of community services in areas of economic decline. Formulating and evaluating alternatives aimed specifically at improving economic opportunities for disadvantaged minority groups and more generally at combating rural poverty represent a continuing but certainly no less important need than it has ever been.

Improving Consumer Products and Standards of Living

The food and agricultural science system has long recognized the need to monitor the nutritional status of the populace and to improve consumer and homemaking skills. However, the scope and prominence of consumer interest and family living issues have increased markedly in recent years and are expected to continue to do so in the future.

Future concerns and needs regarding both human nutrition and food safety fall into four more or less sequential problem areas. First is the need to learn much more about nutrients, chemicals, and other substances that are good or bad for humans, not only in terms of minimum requirements and maximum tolerances, but also in terms of the wide range of intake-health relationships for different types of individuals under different circumstances. Next is the need to know much more about the composition of the vast array of foods available to consumers and what happens to the

nutrients, chemicals, biological organisms, and other substances at various stages of processing, distribution, and preparation. Third is the need to know more about consumption patterns among various segments of the population in order to identify groups which are at risk in terms of deficiencies or excesses or which might otherwise benefit from improved diets. Finally, there is a need to encourage corrective or remedial actions through educational or informational means or through assistance to action and regulatory agencies charged specifically with improving human nutrition or protecting the interests of consumers.

Improving human diets and consumer skills associated with food buying and preparation constitute a major aspect of the continuing need to expand homemaking capabilities and improve conditions of family living. Evaluating and improving the effective utilization of the ever changing kaleidoscope of consumer goods and services and helping families to cope with inflation, energy shortages, and other economic or social problems through home-management education and improved information are other examples of the wide range of family living issues which will need to be addressed in the future.

Contributing to International Cooperation and Agricultural Development

Because of continuing and growing concerns about shortfalls in world food production and inequities in its distribution, international cooperation in improvement of agricultural production and the distribution and storage of agricultural products should receive increased attention in the next 5-year period. The continuing differences in agricultural technology levels and science and education capacities of the North vs. South and East vs. West countries signal the need for increased interaction with developing countries in adaptive research, new and enhanced methods of technology transfer, and training.

Increased agricultural research and technology cooperation and coordination with the developed countries are also indicated as areas of concern for the next 5-year period. Our increasing global interdependency, common problems concerning energy resources and conservation, atmospheric carbon dioxide buildup and acid rains resulting from increased coal usage, tropical deforestation and desertification, and shared water resource concerns are examples of issues which need to be addressed cooperatively on an international basis.

Improving Industry-University-Federal Cooperation and Coordination in Agricultural Research, Development and Technology Transfer

With growing concerns about technology depletion, decline in innovation rate, and the need for increased basic research, increased

cooperation, and closer communications among industry R&D officials and managers, university scientists and administrators, and the scientific staffs and management of USDA is a necessity for the best interests of the Nation. Communication techniques and networks and increased understanding of each other's problems and programs need much more attention in this next 5-year period. A very important need is that of defining and obtaining general understanding of the role and responsibilities of each of these sectors in the basic research, applied research, development, and general application continuum in the various areas, especially in the general area of post-harvest science and technology.

PROGRAM DIRECTIONS AND AREAS PROPOSED FOR INCREASED EMPHASIS IN THE NEXT 5 YEARS

The issues and concerns described in the previous section reflect the general scope of needs and demands which the agricultural research, extension, and higher education system must consider as it works for improved conditions for producers and consumers. These issues have been captured in a general sense by a large number of national conferences, seminars, reports and articles since 1975. They propose, in total, a generalized foundation for program and resource requirements for the food and agriculture system, consistent with public demands and needs. However, the administrators, managers, and staff of the food and agriculture science system must "flesh-out" these general concerns with more specifics and identify those which should receive increased commitments of expertise and other resources in the next few years.

Areas of emphasis which should be considered for increased resource commitments in the next 5 years, most of which are cross-cutting (multi-disciplinary and/or multicommodity, and multifunctional--i.e., with research, extension, and higher education components) are briefly outlined below. Though not always explicitly identified, all of these topics are considered to contain extension, education, and research components, unless specifically identified otherwise. They are not listed in priority order. The listing is not intended to be all-inclusive; it presents those which the Joint Council feels deserve extra consideration in view of the issues and concerns described in the previous section. Again, the importance of maintaining strong, continuing base programs across the broad spectrum of the food and agriculture sciences is emphasized.

Productivity and Yield Levels

- Maintenance of strong base programs in science and education
- Additional investment in research and education to increase rates of technological change
- Increase in basic research that will add to the technology reservoir
- Evaluation of relationships and trade-offs among productivity-increasing activities, environmental quality concerns, and economic returns to farming

Energy

- Conservation in agricultural production and processing, including education programs for rural homes

- Development of alternative sources from agriculture, including the use of biomass from forests and sugar crops

- Development of biosynthetic hydrocarbons (plant-derived hydrocarbons as replacements for fossil hydrocarbons)

- Economic assessment of energy conservation and development alternatives in agriculture, including impact on U.S. balance of payments and other macro-economic effects

Basic Research

- Analysis and synthesis of growth regulators, enzymes, and hormones for improved productivity of plants and animals

- Research on cell membranes, especially relating to the movement of hormones and toxins into and from cells of plants and animals

- Establishment of key linkages to hasten application and exploitation of recently acquired basic knowledge about photosynthesis, nitrogen fixation, and molecular genetics

- Transfer of basic recombinant DNA knowledge to practical, commercial uses of recombinant DNA technology, leading to new enzymes, nitrogen fixation in nonleguminous plants, and advances in immunology and other means of disease control.

Water Resources

- Expansion of programs which address the issue of future water supplies for agriculture, especially where there is ground water mining. Water may be the major limiting factor in food and fiber production for the future

- Development of alternative approaches to deal with competition from urban areas and other uses for traditional agricultural water supplies

- Development of technology to meet conservation needs in irrigated agriculture

- Improvement of water quality and yield from forested watersheds

Conservation of Other Natural Resources

- Evaluation of enviromental impacts of conservation tillage with its increased use of herbicides and extension of its range of application because of its erosion control potential

- Assessment of the resource implications of producing for an expanding export market in relation to conservation concerns

- Development of renewable resources extension and education programs

- Determination of the movement and fate of agricultural chemicals in soils, sediments, and water

- Assessment and reduction of acid rain impacts on forest, crops, fish, and wildlife

- Conservation/development options with respect to prime agricultural land and commercial forest land

Weather and Crop Yield Forecasting

- Improvement of methods for acreage and yield forecasting, including the impact of weather on crop yields

- Provision of improved and increased weather information to producers and agribusiness

- Development of improved technology and production practices to cope with adverse weather

Integrated Pest Management for Agriculture and Forestry

- Acceleration of systems development efforts; increased basic research support

- Further extension of applications to forest systems, stored agricultural products, animal protection, and to suburban-urban and household situations

- Expansion of Extension programs in IPM to commodities and counties not presently covered

- Improvement in coordination among functions (research, extension, and higher education) and among agencies

Forestry Production and Management

- Additional research to increase the supply of wood through better utilization and improved silvicultural practices; emphasis on education and technical assistance programs for owners and managers of small private forests

- Expansion of research and education programs dealing with Eastern hardwoods

- Genetic improvement of trees

- Protection against insects and diseases, emphasis on integrated pest management techniques

- Improvement of forest engineering systems

- Improved utilization of low quality trees and forest product residues

Rangelands

- Increase in research and education programs on integrated management concepts for range

- Improvement of range conditions; quantitative methods for evaluating range

- Methods for protection of fragile range ecosystems against erosion and other deterioration

Improving Crop Productivity and Protection

- Application of recent basic research gains in plant breeding and crop improvement programs

- Development of multiple approaches to stress resistance and tolerance of plants to drought and restricted water supply, saline waters, diseases, and insects

- Increased attention to maintenance of genetic diversity and germplasm resources

- Use of systems approaches to implement combinations of technologies to increase productivity

Improving Animal Productivity and Protection

- Increase in multidisciplinary attacks on reproductive, respiratory, enteric, and exotic diseases--research and education in support of control programs

- Increase in emphasis on reproductive efficiency

- Application of recent basic molecular genetics, hormone and growth regulator research to improve genetic capacity, disease resistance, and reproductive efficiency for animal production and for increased efficiency of feed utilization

Marketing and Cost Reduction

- Development of improved marketing education programs to meet increased information needs of producers
- Reduction of on-farm losses and development of improved harvesting technology
- Evaluation of impacts of changing market structures and institutions on producers and consumers of agricultural products

Post-harvest Processing, Handling, Storage and Distribution

- Reduction of post-harvest food losses
- Development and/or evaluation of alternative transportation practices and systems for agricultural and forest products
- Increase in industry, university, and Federal cooperation and/or coordination, including role and responsibility clarification
- Methods for reduction of human exposure to processing dusts and chemicals
- Assessment of the economic consequences of post-harvest technology developments, including price implications

Improving Socioeconomic Aspects of Rural Living

- Evaluation of needs and alternatives for service and facilities to accommodate population growth in rural areas
- Development of research and extension programs to stimulate community development
- Analysis of alternative methods for overcoming rural poverty
- Assessment of the forces affecting the structure of agriculture and their implications for the family farm
- Assessment of needs and implementation of appropriate research and education programs for small or part-time farmers

Improving Human Nutrition

- Expansion of nutrition information and education programs; definition and promotion of improved diets

- Increase in research relating to the nutrient composition of foods

- Improvement of the knowledge base regarding human nutritional requirements for growth, development and disease reduction; emphasis on infants, pregnant and lactating women, and the elderly

- Further development of techniques for monitoring dietary intake and nutritional status

- Determination of factors influencing food preferences and acceptability.

- Evaluation of government policy options relating to human nutrition

Other Food and Consumer Concerns

- Increase in food quality and safety research and education, including protection against natural toxicants and additives

- Increase in consumer information and education activities

Training and Manpower Needs and Concerns

- Provision of additional interdisciplinary training programs, especially in IPM

- Development and assessment of programs to address concerns regarding the current low supply of scientists in several fields especially nutritionists and agricultural engineers

- Assessment of the causes behind the present underrepresentation of women and minorities in the agricultural science and education system and development of appropriate remedial actions

- Development of training programs for urban and "nonfarm" students

International Cooperation and Trade in Agricultural Products

- Increase in cooperative activities with developing countries, with emphasis on technology transfer, adaptive research, and science and education institution and capacity-building in targeted program areas and countries

- Expansion of cooperation, coordination, and information and technology interchange with Developed Countries on topics of high joint mutual interest, including energy resources, biological controls of pests, water resources, and atmospheric pollution concerns as they impact agriculture and forestry

- Assessment of impacts of multi-national trade negotiations and currency realignments on U.S. agricultural exports and international agricultural development

Technology Assessment

- Determination of the environmental and sociological impacts of new and emerging technologies

- Analysis of positive and negative economic externalities associated with production and post-harvest technological developments

- Assessment of the effects of technological change on income distribution among agricultural sectors (inputs, farming, and marketing), among regions, and among factors of production (land, labor, and capital)

- Analysis of the impact of technology on the structure of agriculture (number and size of farms, competitiveness of product and input markets, and the institutional infrastructure of agriculture)

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